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the author.*

IMPROVED METHODS
OF
HOUSE-DRAINAGE.

BY

WM. PAUL GERHARD, C. E.

Consulting Engineer for Sanitary Works.

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A PAPER READ AT THE MONTHLY MEETING (December 5, 1894),
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Improved Methods of House-Drainage.

MR. PRESIDENT AND GENTLEMEN OF THE ARCHITECTURAL LEAGUE: —

YOUR committee has honored me with an invitation to prepare a paper for this meeting, and has left me entirely free to select some topic from the wide and constantly growing field of sanitary engineering. The sanitation of houses, school hygiene, hospital construction, rain-baths, domestic gas-lighting, the sanitary features of the laying out of cities, water-supply, fire-prevention and fire-extinction, the safety in theatres and halls of amusement, — these were some of the numerous subjects which occurred to me as being of interest to the members of the Architectural League.

After thinking the matter over for some time, I concluded that it would be better to select a subject in which I have been most actively engaged in the past years. Accordingly, I decided to speak to you on "Improved Methods of House-Drainage," although I was well aware of the fact that I could not attempt to treat the matter from any novel point of view. For while the subject is of paramount importance, and one in which every architect takes an interest, it has been quite frequently discussed, and there are numerous books, pamphlets, essays and lectures which go into the matter very fully.

I can, therefore, assure you that it is with the utmost diffidence that I come before you to-night to give a brief address on what many of you will doubtless consider a dry and uninteresting subject.

My endeavor will be to explain some important improvements which have been brought about in the past ten years in the art of draining houses.

To begin with, one quite noticeable improvement relates to drainage plans. Until a comparatively recent period of time, it was an exception to find elaborate plans and sections of the plumbing and drainage system of buildings. The location of the plumbing fixtures was, to be sure, indicated on the floor-plans of the building. Beyond this, very little information was given. It was not usual to mark the number and sizes of soil-pipe stacks, neither was the run and course of the drains indicated on the plans. I believe I am not mistaken in stating that in architects' offices, the practice of making a special drainage-plan began with the enactment of the plumbing laws. At least, I remember distinctly that, when as chief engineer of a house-drainage company, it was my privilege, about ten years ago, to estimate in some of the prominent architectural offices in this and in other cities, I was given plans to estimate on where the drains and soil-pipes were neither shown, nor enumerated or described in the specifications. All this has undergone a great change in the past few years.

Owners of buildings are much benefited by the plumbing laws which require plumbing plans to be filed in the City Health or Building Departments. Even where in the actual construction of the work, the drainage-plan is, more or less, modified, there is kept on record a usually tolerably accurate plan, showing the position of pipes, in case of future reference. In important cases, a revised drainage-plan is subsequently made, showing the work as actually put in. The contractors are benefited by it, because they know better on what work and what quantities to base their estimates. Their workmen on the building are, likewise, benefited, because they can find, by referring to the plans, where the pipes are intended to be run. The architects and the building superintendents are benefited, because they do not have to answer so many questions to the foreman in charge of the plumbing and drainage, and because their time is not so much taken up at the buildings in course of construction with the laying out of the sometimes complicated work. The many advantages, resulting from well-considered drainage-plans, become particularly apparent in the case of large and important structures, such as hotels, hospitals and modern office-buildings.

Another improvement relates to plumbing and drainage specifications. While formerly plumbing specifications were somewhat indefinite and too general in character, with the inevitable result that estimates for the work ran widely apart, it is now universally recognized that plumbing is a question of vital importance in building construction, and much more care is exhibited in the preparation of the specification. Other things being equal, it is self-evident that the more thoroughly detailed and accurate the specifications are — which does not necessarily mean elaborate — the closer will the bids for the work run, and the more will the finished work conform to the expectations of the architect or his client. In this connection, permit me to state that the too general use of the printed blank plumbing specifications of the Building Department for contract work is not, in my judgment, to be approved. Such blank forms may be exceedingly convenient and labor-saving for the inspectors of the Department, but for all, except the smallest houses or tenement buildings or simple warehouses, they are not sufficiently detailed. A contract for a large job should be based on a separate type-written or printed specification. Too much care cannot be bestowed upon the specification. It is my experience, and doubtless it is yours, that the number of extras in the final plumbing bills is inversely in proportion to the completeness of the specification. I refer here, of course, only to the extras which the architect finds himself compelled to order, owing to omissions in the original specifications, and I do not include those sometimes quite numerous extras, which owners or building-committees require.

Now let me turn to the question of materials. Here, too, we cannot fail to find numerous and important improvements. Formerly the house-drain inside the building consisted of earthenware pipes. The soil-pipes were run of lead pipe, with hand-made seams. You are, I trust, sufficiently aware of the objections to such materials. Happily, they have gone out of use. The first improvement consisted in using iron pipes for drains and soil-pipes. For many years it was customary to use the so-called light or standard plumber's soil-pipe. When the testing of drains by the water-test began, the objections to these pipes at once became apparent, it being a most difficult matter to caulk joints in light pipes so as to be permanently air and water tight. Hence, it came about that, at least in the case of the better class of buildings, extra-heavy cast-iron pipes were

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specified. From this time dates the curious practice, which I have often met, of specifying heavy pipe for the main drain, and light pipe for the vertical soil and waste pipe lines. Still later, when the practice of "back-airing" traps began, we find heavy pipes specified for both, the drain and the soil-pipe system, whereas light pipes were considered sufficiently good for vertical lines of vent pipes. A chain is not stronger than its weakest link, and I know you will agree with me that it was a mistake to use two grades of pipe for the soil, drain and vent pipe system of a building. As is well known, the use of extra-heavy pipes is now in this city compulsory in all classes of buildings, from the cheapest tenement-house to the finest private mansion. It is, perhaps, well that the rule is compulsory, for otherwise we should find unscrupulous plumbing contractors and speculative builders still making use of what they must know is an unsatisfactory material for drainage. Cast-iron pipe, even of the heaviest and best quality, is apt to have sand-holes or imperfect seams, hence by far the greatest security lies in ordering from the manufacturers, pipes and fittings which have been *tested* at the foundry by hydrostatic pressure.

The most recent improvement, as regards this point, consists in the more extensive application of screw-jointed, wrought-iron pipe for drainage purposes, particularly in the case of high buildings. Having been, to some extent, personally connected with the introduction of this system in the Eastern States, I cannot help remarking that a wonderful change in opinion has taken place, in architects' offices, and to a certain extent also in plumbers' shops, regarding the merits of wrought-iron pipe, and the use of screw-joints in place of lead-caulked joints, for purposes of drainage. It is scarcely ten years ago, when it was my privilege as engineer of a now defunct house-drainage company to discuss with architects the advantages incident to the new method of drainage. A few architects went on record as in favor of the screw-joint construction. The majority, however, guided in many cases by the advice of the plumbers, estimating in their offices, were opposed to the use of wrought-iron for drain, soil and vent pipes. The pipes which were used then by the advocates of the screw-jointed wrought-iron system were without exception protected against rust, either by a thorough application of coal-tar, or by dipping the pipes, while heated, into a bath of hot asphalt, or else the pipes and fittings were made rustless by the

Bower-Barff process, or finally, galvanized pipes were used, particularly for vent lines. You will readily understand my surprise, to find at the present time, buildings in which plain wrought-iron pipes are used for purposes of house-drainage, the pipes not being in any way protected against corrosion. The mistake — for a mistake it is — can be explained only by the fact that the Building Department requires cast-iron pipe to be plain and uncoated, but wrought-iron piping should, in my judgment, always have some protecting coating against rust.

Other improvements, relating to materials, consist in the more extensive use of drawn-lead traps, and of brass traps, in place of cast-lead pipes, or of lead traps with hand-made seams. I must, however, sound a note of warning against the use of certain brass traps with cast partitions, which are often found to have sand-holes, and are then, of course, only a delusion and afford no protection against sewer-air. The use of very light brass tubing, for exposed waste or vent pipes, should be guarded against, as also the use of light brass traps, or of traps with rough inside surfaces. Finally, the brass pipe should be of iron-pipe size, *i. e.*, full bore, and not restricted in diameter.

I pass on now to the consideration of important recent improvements regarding the sizes of pipes used for drainage purposes and the manner of laying the drains. Of the old brick drains of large size, square in shape and ill-adapted to the removal of household wastes, it is not necessary for me to speak, as they belong to a former generation, although they are occasionally, even now, unearthed in the overhauling of older mansions. Up to within a recent period, it was the custom to use for house-drains, round pipes which were much too large in diameter to perform their function in a proper manner. Even the smallest house had a six-inch drain; larger buildings had nine, ten and even twelve inch pipes. There is no advantage, and there are considerable disadvantages, in using pipes of too large bore. The old-fashioned absurd ideas regarding the necessity for large pipes are now abandoned. The use of small drains is a distinctive achievement of modern sanitary drainage. It is usual, at present, to use a four-inch pipe for the smaller houses. An average-sized four-story dwelling can be efficiently sewered by a five-inch drain, and a six-inch sewer is sufficiently large for a mansion. Extensive buildings, such as institutions, office-buildings, etc., may

require a pipe of larger discharging capacity, but in that event it is preferred to use two or more drains of restricted size as being more liable to be self-cleansing.

To illustrate: The entire waste water from the plumbing fixtures in such an extensive building (vertically) as the Manhattan Life Insurance Company's building, comprising two hundred and five wash-basins, twenty-four sinks, fifty-two urinals, sixty-two water-closets and including all the roof-water, besides various other wastes, is successfully removed by means of two six-inch pipe-sewers laid with a fall of one-quarter-inch to the foot.

The same principle applies to the soil and waste pipes of houses. Formerly five and six-inch soil-pipes were commonly used in private houses, and the sink waste-pipe was, at least, three, and often four, inches in diameter. It is now the rule to make soil-pipes of private dwellings four inches, and kitchen-sink wastes are purposely restricted in size to two inches, in order to be more self-cleansing. As regards the branch wastes from fixtures, the modern tendency is to use small pipes, and not only a vast improvement, but also economy in design, is thereby effected. The traps under fixtures are likewise restricted, with the advantage that they are kept better flushed. It is, under any circumstances, a difficult matter to keep traps perfectly clean, but better results are undoubtedly attained where the diameter of traps is restricted, in order to concentrate the stream and thus utilize the same in scouring the channel.

One other point in connection with sizes of waste-pipes is worth mentioning: I refer to the rain-water or conductor pipes. The sizes of these pipes — in fact, of all vertical waste-pipes — cannot be determined by mathematical rules. Whereas sizes of horizontal or graded pipes can be calculated accurately by means of hydraulic formulas, or by tables evolved from these, I know of no rule by which to determine the diameters of leader-pipes for roofs of given areas and of known pitch. I have likewise been unable to find rules derived from practical experience, or from actual tests and experiments, although I have hunted high and low for them. The only rule which I was able to find was in a recent German architectural text-book, according to which publication the diameter of a leader-pipe may be determined by allowing an area of one square inch in the pipe for each sixty to seventy square feet of roof-surface. I presume the smaller size is intended for roofs of a flat pitch, and the

larger size for steep roofs. It is not stated for what rate of rainfall the rule is applicable. Speaking generally, heavy rainfalls are much more frequent in our climate than in Germany, so that I should advise increasing, where this rule is followed, the diameter obtained, somewhat, to provide for efficient roof-drainage in case of very heavy sudden showers. This question of determining the size of conductor-pipes is one that constantly occurs to architects and sanitary engineers, and it is to be hoped that experiments may be undertaken tending to the solution of the problem from a practical point-of-view.

This brings me to another question, viz: The manner of laying drains. Whereas formerly drains were buried in the ground, and thus became entirely inaccessible, it is now much preferred to carry the main drain of a house in plain sight, above the cellar-floor, either suspended from the ceiling, or fastened along the cellar wall. Until quite recently it was the rule, where the drain was unavoidably laid beneath the cellar floor, in order to drain fixtures on this level, to place the pipe in a trench formed of brick walls with a concrete bottom, and covered with an iron cover. The drain was thus kept accessible in its entire length. A few architects and some engineers still favor this method of construction. In my judgment, it is more preferable, after the underground drains have been thoroughly tested and made watertight, to bed the same in the concrete, and to rely for access upon a number of suitably-placed and suitably-arranged cleaning hand-holes, made accessible by brick man-holes, with iron covers. Underground trenches, as usually built, are too liable to become rat runs, to accumulate dampness and dirt, and to constitute harboring places for vermin. Such inspection and cleaning hand-holes are very desirable in a drainage system, and they should be abundantly provided even where the pipe is carried above the floor, in order to avoid the cutting of pipes, a habit only too common with thoughtless mechanics in case of a stoppage in the pipes.

Let us now give brief consideration to a further point, in which house-drainage has been greatly improved. Some years ago plans for the drainage of houses were submitted to me, in which the water-closet pipes or soil-pipes were kept separate and distinct from bath, lavatory and sink wastes. This double system, as you will readily comprehend, rendered the drainage system much more complicated and vastly more expensive without any corresponding advantage. This mistake, doubtless, arose from following too closely the

prevailing English practice as described in the English text-books on plumbing. In the absence of any practical American books on house-drainage and plumbing, architects had to rely largely, ten and more years ago, on the study of English works on drainage. It is not necessary, nor even desirable, to do this nowadays, as there are available several good books on the subjects by American authors, which clearly describe the American practice. Other features of the English practice of draining houses, which are equally inapplicable here on account of differences in the climatic conditions, are the placing of the soil-pipes on the outside of the house, and the running of the smaller wastes, such as bath and basin wastes over outside gullies.

A further curious mistake, which I have encountered in plumbing plans, is the requirement that in case of bath-rooms with water-closets located vertically over each other on succeeding floors, there should be a separate line of soil-pipe for the bath-room of each floor, thus entailing a needless complication, a multiplication of soil-pipe stacks and a greatly increased cost of the plumbing. The exactly opposite principles are followed to-day: the work is simplified as much as possible; plumbing fixtures in houses, planned by architects, are grouped together, and the drainage is concentrated, as far as practicable, in a single line of pipe, thus securing an abundantly flushed line, and economy in construction.

Not very long ago, the pipes pertaining to the drainage system of a house, were universally put out of sight and the fixtures concealed by expensive but useless cabinet-work. Drains were placed under the cellar floor and rendered inaccessible, soil-pipes were built into the walls, waste and vent pipes bedded in plastered partitions, supply-pipes were run under hard-wood or tiled floors. In case of accident to any of the pipes, nobody knew where to look for them, floors were torn open, the plastering cut, rich wall-decorations destroyed in the efforts to reach the pipes. One of the chief features of modern work is the exposure of all pipes. Architects and owners have now become accustomed to this improvement; there are many who even fancy the new arrangement. By a clever study of the house plans, it is often feasible to carry pipes exposed, *i. e.*, outside of walls or partitions, even on the parlor floor. I have found on this floor the main pipe lines kept accessible by a hard wood hinged pipe-casing, in some houses built by our most prominent architects,

What a great contrast with the builders' method of the past of boxing everything up, — pipes, fixtures and all!

Just a few words on the so-called open arrangement of fixtures. A decided improvement in the character of workmanship has been brought about by the improved method of keeping plumbing-fixtures exposed to view. The advantages from the point-of-view of maintenance of cleanliness and ease of inspection are too apparent to need further discussion. I wish to dwell, however, for a moment, upon one point which seems to be less well understood. In conversation not long ago with one of our busiest architects, he remarked that the open arrangement of plumbing-fixtures entailed a largely-increased labor on the part of servants and, therefore, was not looked upon with favor by householders. This is, without doubt, true of exposed nickel-plated piping. It must not be overlooked, however, that nickel-plated work and exposed work are not one and the same thing. You can have one without the other. From a sanitary point-of-view, a job may be equally well, and equally safely done if constructed of lead and afterwards merely painted or bronzed. Where more elaborate or expensive work is desired, the piping may be electro-copper bronzed or finished in oxydized silver, which do not require the constant polishing which nickel finish needs to keep it bright.

Whereas in former years plumbing-fixtures were scattered all over the house, necessitating a complex system of plumbing-pipes, and often endangering the health of the occupants by ill-contrived and defective fixtures placed in the bedrooms, the modern practice of architects, and one which cannot be too highly praised, is to confine plumbing work to the bath-room, to the kitchen, pantry and laundry. The necessary fixtures are placed, as far as the house-plan permits, in vertical groups, and all appliances, and the water-closet and slop-sinks in particular, are placed in well-lighted and well-ventilated apartments.

There is one mistake, however, which is still frequently committed, to which I beg permission to draw your attention. The mistake to which I allude is the placing of the water-closet in the same room where the bath-tub or the wash-basin are located. This is objectionable on æsthetic as well as on practical grounds. It is particularly so in the case of the smaller houses, and in apartment-houses, with only one bath-room. In more elaborate houses of rich people, where

there are several bath-rooms, the separation of the water-closet is not so necessary for practical reasons, but I think that a bath-room with a water-closet can, in all cases, be made much more inviting by contriving an ornamental screen, or a low partition separating the water-closet from the other fixtures. The partition may be lined with marble or tiling and its upper part may be constructed of open fretwork. I have in mind several exquisitely-finished bath-rooms, designed by progressive architects, in which this division of the room was made a successful and greatly-appreciated feature.

Much improvement is noticeable in the selection of suitable and sanitary plumbing appliances.

The objectionable pan-closet is seldom encountered in modern plumbing-work, plunger-closets are out of date, valve-closets are no longer fitted up, and improved water-closet troughs have taken the place of the former privy sink. Wooden laundry-tubs are no longer common, because better tubs of non-absorbent material may be obtained cheaply.

As regards the most important sanitary fixture, namely, the water-closet, the number of apparatus of different make and construction is legion. Practically, however, the choice lies between only a few approved types, viz: the flushing-rim long hoppers, which are good but require a large quantity of flushing water, and the improved pedestal short hoppers; the siphon and the siphon-jet closets; and finally, the so-called wash-down closets, having a vigorous and direct flush. You may notice that I do not include in this list the wash-out closets, because while I do not wish to condemn them too severely, I cannot bring myself to regard them with much favor. They have several objectionable features, which do not commend them to me as a perfectly sanitary fixture. They are, notwithstanding these facts, very popular at the present time. Popularity, however, is not always a just criterion of fitness, for the same thing may be said to have been the case with the Jennings and the Zane plunger-closets, with the Hellyer or valve closet, etc., all of which are now out of date.

Two points require careful attention, where porcelain water-closets are used, one is the floor-joint, which being on the sewer side of the water-closet trap, must be made tight. The other is the connection between the piping and the earthenware horns of the bowl. If these are made rigid, breakage of the earthenware is the result of

the slightest settlement of the floor. A flexible connection is, therefore, much to be preferred and can now be obtained with many of the types of closets named.

The limits of this paper do not permit my discussing in detail the requirements of water-closets, and I must pass on to review briefly the other plumbing appliances of houses.

Speaking of wash-basins, we may distinguish four principal types, viz: 1, tip-up basins; 2, chain-and-plug basins; 3, open stand-pipe overflow basins; and 4, secret waste-valve basins.

Tip-up basins are generally condemned, because in their usual form they have objectional features. If the receiver could only be arranged so that it would not become foul, or that it was readily accessible for cleaning, this type of basin would have many merits. It is, without doubt, very convenient in use, has no concealed overflow, no chain and plug, is rapidly emptied and flushes its waste-pipe and trap well at each discharge.

The objections to the second type, the common chain-and-plug basin, are too well known to need further comment. It is proper however, to state that there have recently been put upon the market some modified forms of this type, which I consider great improvements upon the ordinary type. One is a siphon-basin, which empties rapidly, and flushes its overflow at each discharge. The overflow channel is so shaped that when the plug is inserted in the bottom of the bowl and the same filled with water, the overflow is trapped. In office-buildings and in hotels, where a stand-pipe-overflow basin or a bowl with waste-valve is too expensive and too complicated for general use, the siphon form of basin has much to recommend it. The other improved form is a chain-and-plug bowl in which the waste outlet has been greatly enlarged, and which has the usually hidden overflow channel made much shorter and accessible by means of a removable strainer.

The third type of basin has an open stand-pipe overflow, and there are numerous modifications of the device for raising the stand-pipe. From a sanitary point-of-view this type has, undoubtedly, the greatest merit of all forms, still my experience has been that the general public is hardly sufficiently educated in sanitary matters to appreciate its merits. By many this form of basin is utterly condemned on account of its odd shape and appearance. The favorite form of basin is just the one which has the most objections from the

hygienic standpoint, namely, the bowl with secret waste-valve. To discuss its objectionable features in detail would lead us too far.

Regarding that valuable fixture for personal cleanliness, the tub or bath-tub, with its various modified forms, such as the foot-tub, the sitz-bath, the hip-bath, the bidet, etc., I would state that tubs of wood lined with copper are less used than formerly in private houses, probably because they always require some sort of wooden casing, and also because they lose their bright appearance in use. Enamelled iron tubs, standing free from the wall and raised from the floor, constitute a satisfactory sanitary fixture, which is only surpassed by the beautiful all-porcelain bath-tubs. Both kinds of tubs are now obtainable with a glazed roll rim, thus doing away entirely with all woodwork. I ought, perhaps to mention in this connection, that a great improvement in the manufacture of American earthenware has recently taken place, and that it is now for the first time possible to obtain porcelain bath-tubs made in this country. In regard to the appliances used for holding water in the bath-tub and for emptying the same, much of what I said of wash-basins applies here. In this matter I may appear to you old-fashioned, when I state that my decided preference is for an open stand-pipe overflow.

For baths in public institutions, for baths in factories, and for people's baths, there is a growing tendency to discard the tub-bath in favor of the rain or spray bath, which is greatly superior from a sanitary point-of-view, besides having many economical advantages.

Slop-sinks and housemaids' sinks are obtainable in a variety of serviceable forms, most of them excellent from the sanitarian's point-of-view. I would only remark that a flushing cistern is quite as essential in the case of a slop-sink as in that of water-closets. An ingenious and novel arrangement consists in a slop-sink, which flushes itself automatically each time slops are emptied into it.

Kitchen sinks are likewise obtainable in a variety of materials. This fixture is much improved by changing the dribbling stream passing through its waste into a quick and effective flush. Attempts in this direction have been made, with some success, and the devices employed are certainly worth considering. Incidentally, the question of avoiding the kitchen grease nuisance is thereby solved, in a better way, to my mind, than by the employment of grease-traps at the sinks, which invariably constitute a nuisance, are usually

forgotten or neglected and are not to be recommended. I must content myself with a mere allusion to the subject.

Of urinals, it is only necessary to mention that in private houses their use is not to be encouraged, as the fixture is very difficult to keep clean. In offices and in public buildings, such as hotels, railroad stations, court-houses, etc., the fixture is a necessity, and great attention is required not only in the fitting-up, but in its maintenance. The projecting lip of porcelain urinals seems to me to be of doubtful advantage. One point in the fitting-up of the fixture is worthy of mention: the bowls are generally set up too high from the floor-slab. I find it is better to set them at a height not exceeding twenty-two inches from top of lip to floor-line, instead of twenty-four to twenty-six inches, as is customary. The floor-slab is thereby kept more readily free from drippings.

In fitting-up plumbing-fixtures, the chief aim should always be the avoidance of woodwork at and around them. All fixtures should stand free from the walls and be accessible on all sides. Even the seats of water-closets are now attached directly to the bowl, the closet thus stands absolutely free and detached from the wall, and the entire fixture can be reached for cleaning and for repairs. In one respect, however, modern plumbing-fixtures are open to considerable improvement: I refer to the undesirable noisiness accompanying the flush and the discharge of the fixtures. This problem, as experience teaches, is not easily solved.

The time at my disposal permits only a brief allusion to the testing of plumbing work. All work should be tested before acceptance, as knowledge of the safety of the plumbing work can only be obtained in this way. I regret to say that I have found only very few mechanics doing plumbing who apply to their work any test, except where this is specially insisted upon by the architect or the engineer. To my mind, it is one of the most important duties which architects owe to their clients, to see to it that all work is tested. For new work we have the water test and the air-pressure test. This should include not merely the main horizontal lines and the vertical stacks, but likewise all the branches, and the brass-ferrule joints. The finished work should be tested by the peppermint or by the smoke test, which help to show imperfections in the joints of nickel-plated piping and at the floor-joints. In the inspection of old work, the water test, which is the best test, cannot, for obvious

reasons, be applied, and here the smoke test, or the test with oil-of-peppermint, intelligently applied, give valuable indications as to the condition of the work.

A great step forward would be made and plumbing-work vastly simplified, by abolishing, or at least, modifying, the trap-vent system. There are at present two quite different methods of arranging the system of trapping the fixtures in a building. In the one system, which is in accordance with the majority of plumbing regulations, and is the one at present enforced in New York City, all traps must be back-aired or vented. We thus obtain a duplicate system of pipelines, the work is complicated, more expensive and may become more unsafe, on account of the greater number of pipe joints and the possibility of "by-passes." The other system — the one-pipe system, as we may call it — is distinguished by its greater simplicity, economy and, as I maintain, by its greater safety. This method substitutes non-siphoning traps or anti-siphon trap attachments for the cumbersome method of back-airing. In this system, all main soil and waste lines must be quite as fully ventilated by extending them the full size up to the roof as in the usual method. All fixtures are located directly at the lines carried up to the roof, or within a very few feet of the same. Siphonage of the traps is impossible under the ordinary conditions, quite as much so as in the back-airing system. You will find the majority of plumbers opposed to the new system: for while it simplifies the work, it reduces the amount of piping used and thereby the cost of the work. There is also much prejudice against the proposition, many plumbers seeming to fear that by putting themselves openly on record as in favor of it, they would by others be considered as not quite up to date in plumbing matters. The fact remains undisputed — and I have demonstrated it in many cases in my practice — that the new method is, at least, quite as safe as the old one. I venture to predict that in a very few years plumbing laws will be so modified as to leave it optional with the owner or architect of a building which method he will adopt.

This leads me to say a few words in regard to plumbing rules and regulations, in particular of those in force in New York City. Further advancement in plumbing requires the revision and improvement of the plumbing laws of the Building Department. Far be it from me to underrate the good which the present rules have accomplished in the past. Ours is not, however, an age in which we can

at any time afford to stand still. Constant progress is made in every department of construction and the researches of the practical sciences are everywhere utilized and embodied in actual practice. Let us hope to see soon a revision of our plumbing laws. Be it remembered that the plumbing rules of our metropolis are being largely copied by other cities. We cannot afford to fall behind in this matter. Our present rules are too indefinite in many details; they are much too arbitrary in others. Take, for instance, the question of sizes of drain-pipes, of soil-pipes, of vent-pipes, the diameter of traps, etc. There is certainly now sufficient practical experience available to lay down more definite rules as to sizes. The rules should also in the future prohibit fixtures which sanitary science has long ago recognized as being absolutely bad. Pan-closets, wooden sinks and wooden wash-tubs should be discarded, and privy sinks should no longer be tolerated.

Before leaving the subject of interior drainage, I wish to consider for just a moment the prevailing practice of doing plumbing work. It is without doubt feasible to have plumbing work done by day's work by a contractor of known integrity, at a certain agreed commission or profit on the net cost of labor and material, without thereby unduly increasing the cost of the work. Still, as a rule, the owner prefers to make a contract for a lump sum or stated figure. In that case, the recent practice, particularly in the case of high office-buildings, of putting the plumbing — and for that matter the heating and power plant, the electric work and the elevator machinery — in the builder's general contract, *for a consideration which usually amounts to much more than the fee of experts who would plan and superintend the work in the owner's interest, cannot be commended.* There is not, to my mind, a single feature of merit in it, and there are, on the other hand, good reasons why these branches, which comprise *the domestic engineering work* of buildings, *should be kept separate* and under the direct control of the architect or the mechanical, electrical or sanitary engineering expert who may be associated with him.

In conclusion, let me say a few words about the outside drainage and final disposal of the sewage, particularly of country houses, not within reach of sewers. These are questions which rarely concern the architect directly, but about which it is nevertheless useful for him to keep informed.

In the case of city houses the outside drainage is apparently a very simple matter, consisting merely in the continuation of the house-drain to the public or street sewer. Still, even the sewer connection requires attention, as is proved by a recent case which happened on the upper west side of this city, where a builder and his plumber connected a whole row of dwellings to the pipe-sewer in the street by merely breaking holes into the sewer and sticking the house-drains through it.

The final disposal of the sewage from habitations becomes a very difficult and sometimes troublesome matter in the case of country and suburban houses, not within reach of sewers. The purity of the local water-supply must be maintained, the contamination of the soil and likewise the pollution of the air must be prevented at all hazards. To accomplish this, the disgusting and health-menacing cesspool and the privy nuisance must be done away with. Bad as a single cesspool is, the evil is only aggravated by the method sometimes pursued of having one cesspool for the water-closet wastes and another for the kitchen-sink wastes, or by having a series of cesspools with connecting overflows.

Two methods of sewage disposal have been devised by engineers which offer a successful solution of the problem. One is the system of sub-surface irrigation, the other the disposal of sewage by irrigation over the surface. Inasmuch as the chief requirements are that sewage be disposed of not alone without injury to health, but also without offence to sight or smell, it is not often practicable to run the sewage over the surface of the ground near the house. Where plenty of land is available, and located at such an elevation that sewage can be conducted to it by gravity, surface-irrigation is by far the best, the cheapest and the simplest mode of disposal.

The other system, the sub-surface irrigation system, has been in successful use in many country places. It has often been described and illustrated, and in a paper like this it is out of the question to go into details. The chief features of this system are the following:

1. Carry the sewage from the house in a tight pipe conduit leading to a sewage or flush tank.
2. Collect the sewage in a double-chambered tank, the first chamber being intended to retain the solids and kitchen grease, while the second and larger tank receives the liquid sewage by a deeply-trapped overflow from the first chamber.

3. Discharge the liquid sewage once or twice a day, by means of an automatic siphon, into an outlet pipe, leading to the sewage field.

4. Distribute the sewage by means of a main conduit with laterals, into a system of absorption drain-tiles, laid with open joints, in trenches twelve inches deep, covered up with earth.

I will not describe the details of the system. I wish to warn you, however, against having such work done by contract. Frequently have I been asked by clients and by architects, to undertake sewage-disposal contracts, but I have always declined to do so. I know that others undertake such contracts, but the results are seldom entirely satisfactory. Often the mistake is made of laying an insufficient number of absorption tiles; with the result that after a season's work the field becomes overcharged with sewage. I also find sewage-disposal systems laid out by others giving trouble because the tiles are laid with too steep a grade, in which case it invariably happens that the bulk of the sewage runs to the lowest end of the field, where it often breaks out on the surface. In other instances, again, I find the distributing tiles laid two, three and sometimes even four feet below the ground surface. This mistake arises from a lack of knowledge of the principles of the system, which require the sewage to be discharged into the upper well-aërated layers of the soil, or the sub-surface, where the action of the bacteria converts the sewage and the particles of organic matter attaching to the earth into harmless elements.

A bad layout of the distributing tiles invariably results in failure. Sometimes the system proves unsuccessful from the omission of the first or intercepting chamber, in which case the tiles become choked in a short time. Insufficient attention to the flush-tank is another frequent reason why the method fails to give satisfaction. Owners of country houses, after adopting this method of disposal, generally make the mistake of assuming that the same is automatic and hence needs, after completion, no further attention. The fact is that nothing is automatic in the system except the siphon for emptying the flush-tank, but every part of the system, including the siphon, needs attention and intelligent care and occasional cleaning.

As regards the flush-tank, it may be either an open or a closed tank, the latter being preferable in all cases where the flush-tank must be placed near the house. The open tank, if at a distance from the house, is better, because it is more readily accessible and

easier to clean. The tank may be circular in shape or else oblong. It is generally built of brickwork, lined with Portland cement. Colonel Waring, who introduced this system from England, has suggested lining such open sewage-tanks with enamelled-face brick, or with marble. I agree with him that this is quite desirable on the ground of greater cleanliness. But in my own practice, I have not been able to meet clients who were willing to incur the extra expense involved, and where I am associated with architects in such work, I find they prefer putting marble or slate or enamelled-face brick, where it will show to better advantage.

There are a great many other things which I would like to bring before you if time permitted. In closing this paper, I thank you for your courteous attention, and trust that some of the points brought up may be new to you, though I fear that to such a progressive body of architects I have but re-told an old story.

